New developments in methods for anisotropic flow analysis

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We discuss three new developments related to the methods for analysis of anisotropic flow in heavy ion collisions; these results are in addition to the ones reported in [1]. 1) The distribution in the magnitude of the directed flow vector in the presense of strong elliptic flow. This is an important case for flow studies at beam energies $E_{beam} < 10 \cdot A$ GeV. For practical use such a distribution can be calculated numerically from the definition:

$$\frac{dP}{dQ_1^2} = \frac{1}{4\pi\sigma_X\sigma_Y}\int \exp(-\frac{(Q_1\cos\phi - v_1 M)^2}{2\sigma_X^2} - \frac{(Q_1\sin\phi - v_1 M)^2}{2\sigma_Y^2})d\phi, \quad (1)$$

where M is the multiplicity, and $\sigma_X = (M/2)(1+v_2-2v_1^2)$ and $\sigma_Y = (M/2)(1-v_2)$. The analogous distribution (Eq. (27)) in [1] was derived under the approximation $\sigma_X = \sigma_Y = M/2$. Fig. 1 shows the distributions in $q_1 = Q_1/\sqrt{M}$ for different values of v_2.

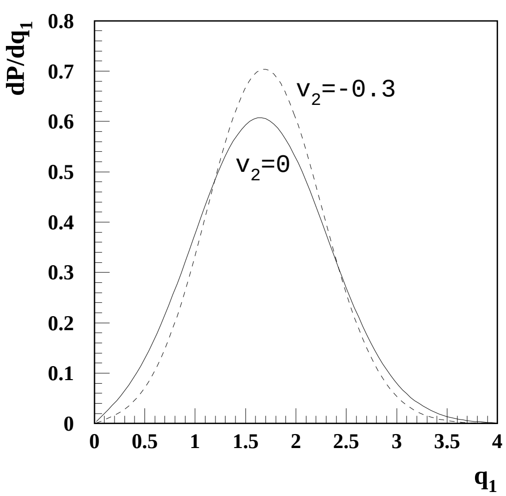

Figure 1: Distribution in $q_1 = Q_1/\sqrt{M}$ for the case of $v_1 = 0.15$ and $v_2 = 0$ (solid curve) and $v_2 = -0.3$ (dashed curve).

2) At RHIC energies elliptic flow is expected to be significantly stronger than directed flow. One can try to improve the resolution of the directed flow measurements by using the event plane angle from elliptic flow modified by the "direction" of the directed flow. The resulting resolution in the limit of strong elliptic flow is

$$\langle\cos(\Psi_1' - \Psi_{RP})\rangle = (4/\pi)\langle\cos(\Psi_1 - \Psi_{RP})\rangle, \quad (2)$$

improved not much (factor $4/\pi$) from using the directed flow by itself.

3) The last development concerns the entire scheme of anisotropic flow analysis. The new approach which we are considering is simpler for calculations, and does not require some of the assumptions needed for the conventional approach. We propose to study scalar products of the flow vectors instead of their correlation in azimuthal space. For example, for subevent correlations we use

$$\langle\vec{Q}_n^a\vec{Q}_n^b\rangle = \langle Q_{n,x}^a Q_{n,x}^b\rangle = \langle v_n^2 N^a N^b\rangle. \quad (3)$$

Then, if one correlates unit vectors of particles in rapidity and p_t bins, one gets

$$v_n(y,p_t) = \frac{\langle\vec{Q}_n\vec{n}(y,p_t)\rangle}{2\sqrt{\langle\vec{Q}_n^a\vec{Q}_n^b\rangle}}, \quad (4)$$

where we use that the "full event" flow vector $\vec{Q}_n = \vec{Q}_n^a + \vec{Q}_n^b$ and "full event" multiplicity is twice the subevent multiplicity. Autocorrelations (in case the particle under study is also used to define the flow vector $\vec{Q}$) can be easily removed by subtracting the quantity from the numerator of Eq. (4).

References

[1] A.M. Poskanzer and S.A. Voloshin, Phys. Rev., C58 (1998) 1671.